

CHEMICALS

Project Fact Sheet



THIN FILM CERAMIC APPLIQUÉS FOR CATALYTIC MEMBRANE REACTORS

BENEFITS

- Estimated energy savings of 20 percent over equivalent air-based combustion systems
- Reduces emission of pollutants, including an 80 percent reduction in NO_x
- Reduces emission of particulates
- Reduces the need for heat recovery systems by lowering exhaust gas volumes and improving melter control

APPLICATIONS

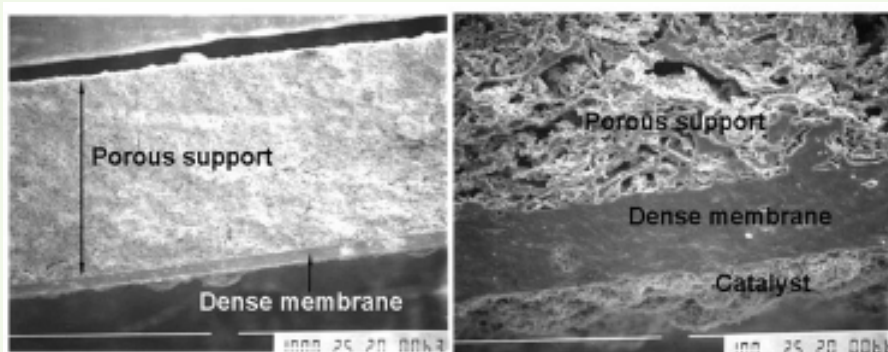
The industries that will utilize this technology for the efficient and cost-effective separation of oxygen from air include: chemicals, steel, glass, petroleum, forest products, water treatment, electronics, health, and medical. In addition to oxygen-based combustion CMRs, direct separation of oxygen from air can be used for natural gas partial oxidation to synthesis gas and methane oxidation coupling.

NOVEL MEMBRANE MANUFACTURING PROCESS INCREASES ENERGY EFFICIENCY

Pure or enriched oxygen-based combustion processes can provide industry with higher energy efficiency and lower emissions. Adoption of oxygen-based technologies has been slow, however, because current commercial technologies to supply oxygen must operate on a large-scale in order to be cost-effective. Catalytic membrane reactors (CMR) can supply oxygen at a reduced scale, but are currently hampered by high manufacturing costs and membrane flux limitations. Project partners are developing a new manufacturing process that will lower the cost and increase the oxygen flux of CMRs, allowing for the economical production of oxygen at smaller facilities.

CMR technology has demonstrated the ability to produce oxygen using catalytic membranes. An applied pressure gradient across the membrane acts as the driving force for the separation of oxygen. However, the oxygen flux of CMRs is currently limited by achievable membrane layer thickness. This project will develop new tape/appliqué techniques to produce dense thin film oxygen-permeable membranes on porous supports. The appliqué process will allow for easy scale-up to commercially useful modules. Project partners are also developing a new generation of mixed ionic and electronic conducting membranes that will increase the mediation of oxygen. Used in concert with the new tape/appliqué process, these membranes will help increase the adoption of energy-efficient, oxygen-based combustion.

THIN FILM MEMBRANE



The thin film membrane being developed using the appliqué process is shown on the left at 50X magnification, and on the right at 500X magnification.



Project Description

Goal: The goal of this project is to develop a unique tape casting technique that will permit the low-cost fabrication of dense, supported thin film mixed ionic and electronic conducting membranes for promoting the efficient separation of oxygen from the atmosphere.

The project's approach relies upon initially tape casting a unique mixed ionic and electronic conducting ceramic membrane material onto a flexible backing made of a wax impregnated paper. The initially tape cast substrate constitutes the appliqué. This ceramic appliqué is then introduced onto the surface of a porous ceramic support, and subsequently sintered to provide a dense, supported thin film membrane.

Progress and Milestones

Initial research results have indicated both the technical and economic feasibility of the novel fabrication techniques. The following are specific technical objectives that were achieved in early-stage research:

- Prepared and characterized thin film membrane precursors
- Fabricated porous substrates with controlled porosity
- Fabricated thin film membrane appliqués and developed lamination techniques for adhesion to the porous substrate
- Evaluated the performance of the thin film membrane in a catalytic membrane reactor (CMR)

Current research is addressing the rapid, reliable, and economic fabrication of supported thin films of mixed oxygen anion and electron conducting membranes for use in catalytic membrane reactors. Research is focused on achieving the following milestones:

- Optimize the tape casting slurries for producing thin film appliqués
- Clarify the role of the appliqué backing in the fabrication and sintering of the supported membrane structure
- Refine the lamination process for adhering the thin film appliqué to the porous support
- Develop an effective porous support for the thin film
- Conduct catalyst development to ensure that the rate limiting step in the oxygen separation is the migration of the oxide ion through the membrane and not surface kinetics
- Optimize the physical and mechanical performance of supported thin films
- Scale-up the supported thin film structures to produce a 10 centimeter diameter disk membrane
- Test fabricated membranes under pressure-driven oxygen separation conditions



PROJECT PARTNERS

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